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## Multiscale patterning of nanocomposite polyelectrolyte/nanoparticle films using inkjet printing and AFM scratching

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# Multiscale patterning of nanocomposite polyelectrolyte/nanoparticle films

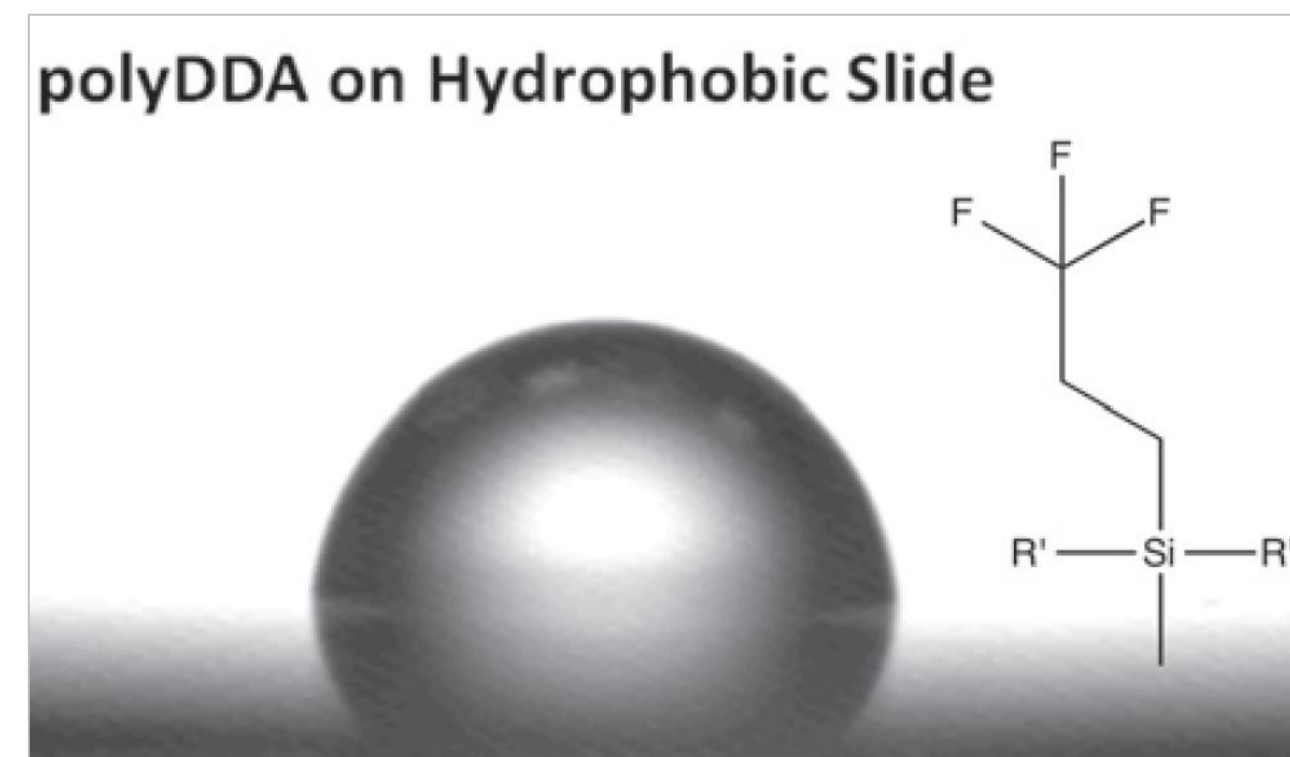
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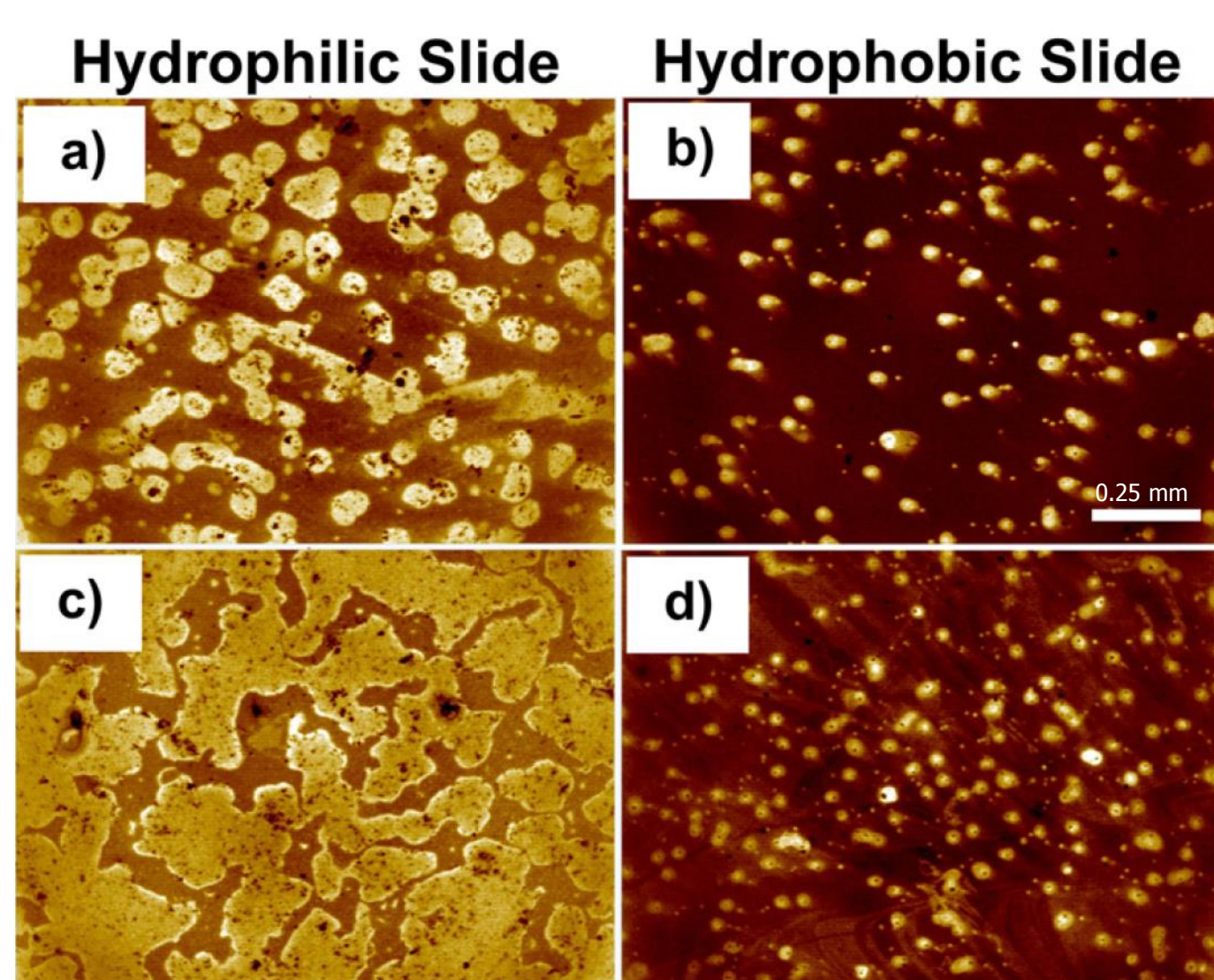
## 1. Introduction

A methodology for printing and patterning cationically charged polyelectrolyte is presented. The spreading of printed aqueous polyelectrolyte droplets is controlled via substrate hydrophobisation using a fluorosilane, which modifies the wettability of the printing surface.

After deposition, the printed polyelectrolyte features are further decorated by immersion into a solution of anionically charged, citrate-passivated gold nanoparticles. Self-assembly via electrostatic attraction leads to the formation of patterned composite polyelectrolyte/nanoparticle films.



## 2. Printing



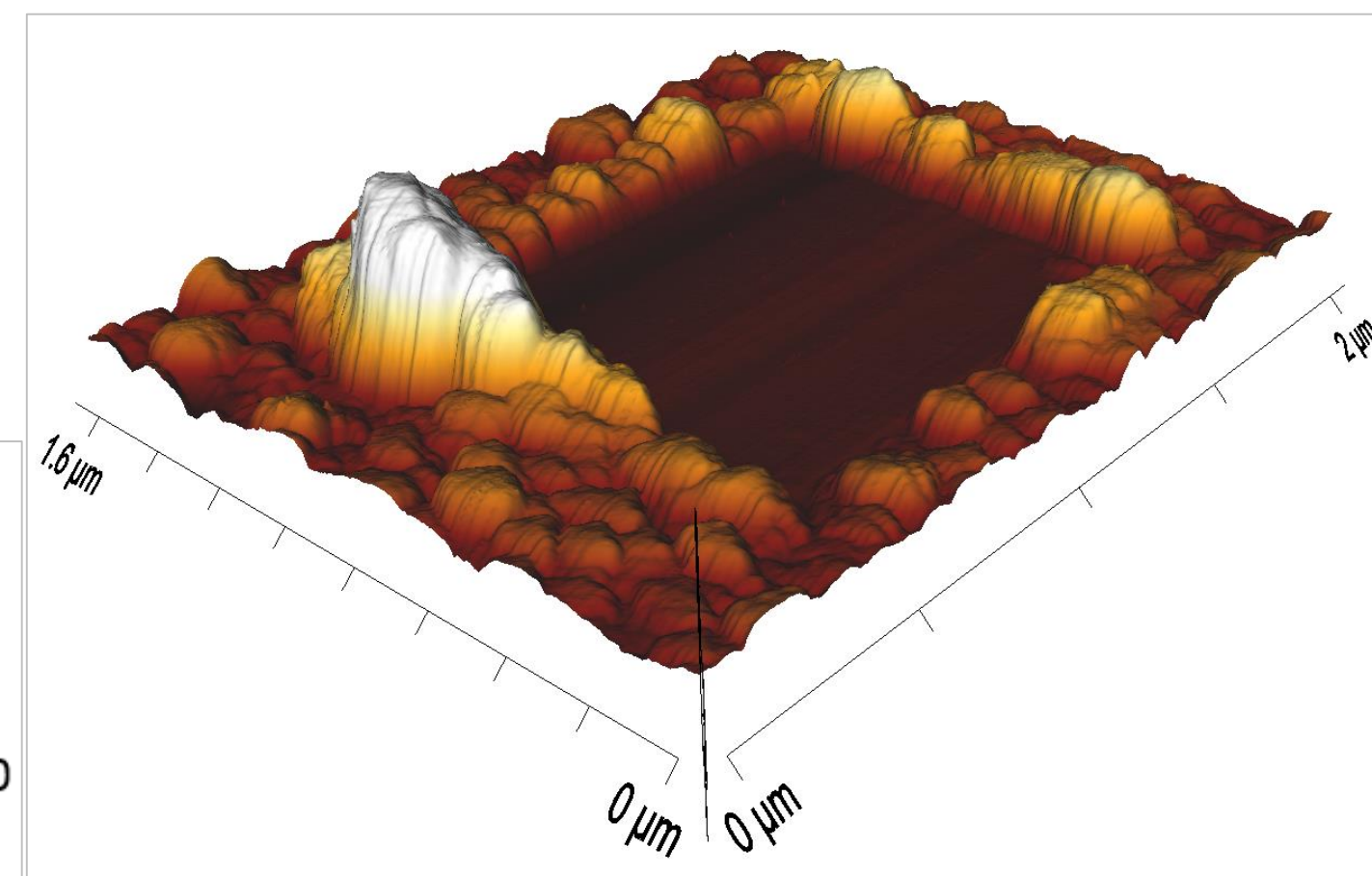
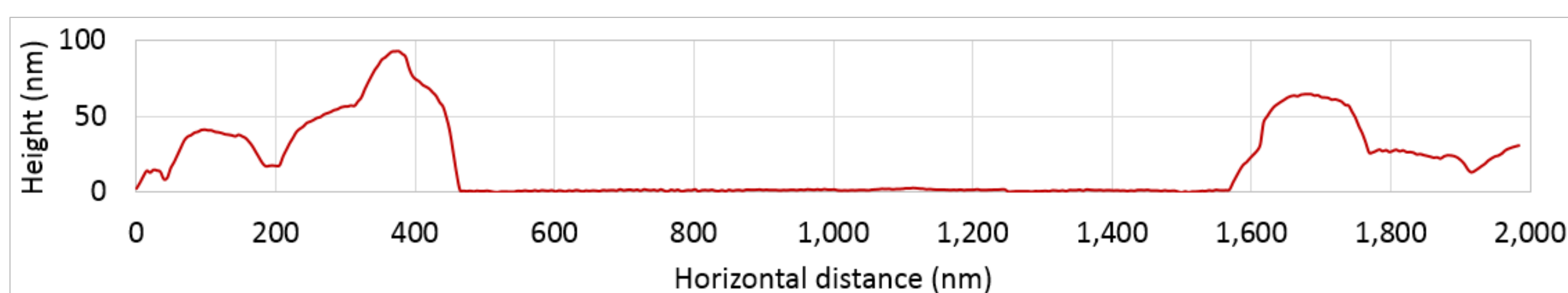
The morphology and distribution of printed droplets was visualised using optical microscopy and white light interferometry.

Printing on hydrophilic surfaces created high surface area features of low vertical height **(a)**. Hydrophobic surfaces led to low surface area features with greater vertical height **(b)**. Droplet diameters were typically in the range 50-70  $\mu\text{m}$  for hydrophilic surfaces, and 10-40  $\mu\text{m}$  for hydrophobic surfaces.

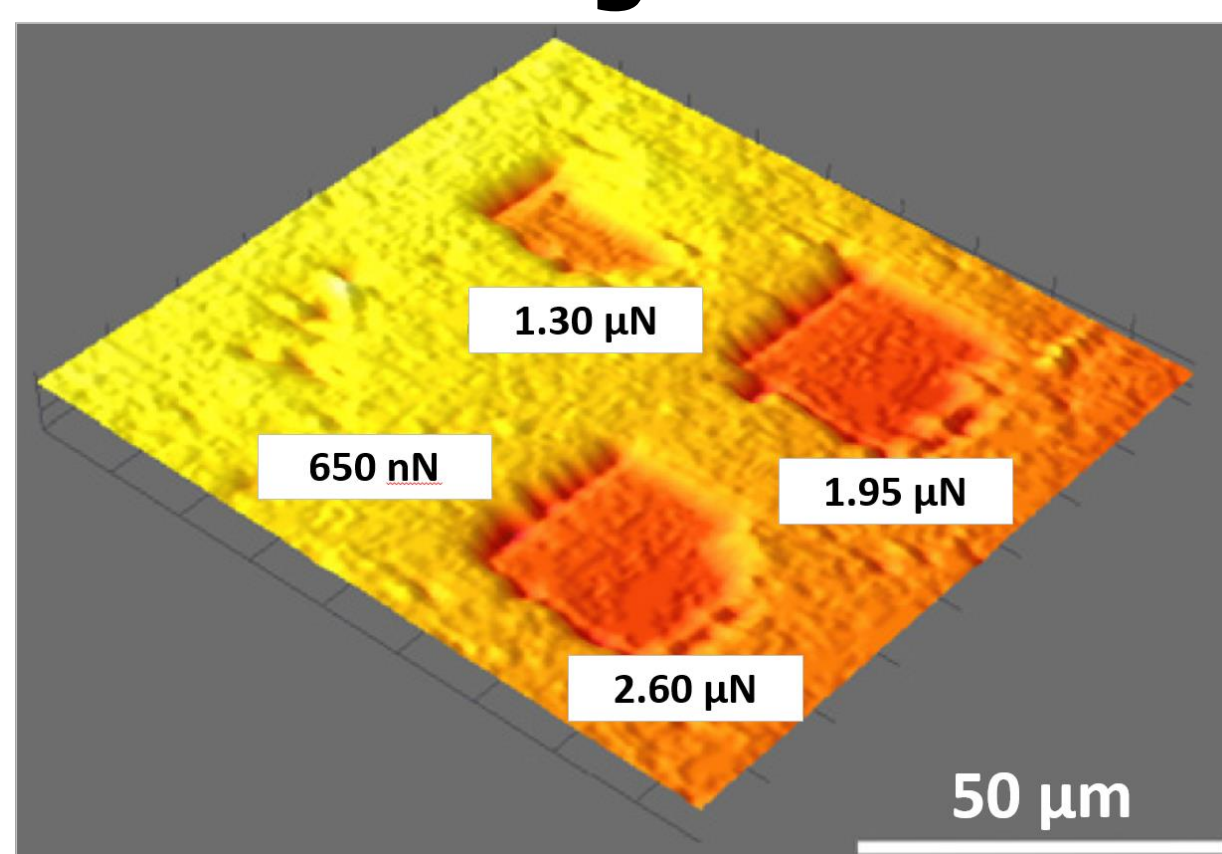
Increasing deposition densities led to coalescence of spread droplets on hydrophilic surfaces **(c)**, although some coalescence is also visible at the lowest printing density **(a)**. In contrast, droplets on hydrophobic surfaces retained their discrete nature **(d)**, except at very high printing densities.

## 3. AFM scratching

A compressive normal load of approximately 2  $\mu\text{N}$  was found to be sufficient for complete removal of printed polyelectrolyte/nanoparticle composite films. Regions of 1  $\mu\text{m}$  x 1  $\mu\text{m}$  were removed using contact mode atomic force microscopy, employing a silicon tip of radius 10 nm.



## 4. Patterning



Extending the AFM scratching procedure to regions with dimensions 25  $\mu\text{m}$  x 25  $\mu\text{m}$  and greater was also achievable, provided a sufficient density of scratch lines was employed. Modifying the compressive normal load enabled height variations to be incorporated into patterned regions.

The lateral forces generated during patterning were lower for composite films deposited on hydrophilic substrates. In some cases it was not possible to achieve complete removal of material for films deposited on hydrophobic substrates. This was due to poor penetration of the silicon tip into the composite film using the range of compressive normal loads achievable.

## Acknowledgements

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The paper can be obtained by scanning the adjacent QR code.

